USDA FY 2011 AVOIDING HARM FROM INVASIVE SPECIES (USDA Do No Harm 2011 Report)

A USDA Report to the Invasive Species Advisory Committee and the National Invasive Species Council by Hilda Diaz-Soltero, USDA Senior Invasive Species Coordinator

February 27, 2012

There are eight U.S. Department of Agriculture (USDA) agencies that work on invasive species issues: the Agricultural Research Service (ARS); Animal Plant Health Inspection Service (APHIS); National Institute for Food and Agriculture (NIFA) (formerly the Cooperative State Research, Education and Extension Service (CSREES)); Economic Research Service (ERS); Farm Service Agency (FSA); Foreign Agricultural Service (FAS); USDA Forest Service (FS) and Natural Resources Conservation Service (NRCS).

Previous USDA Do No Harm Reports cover: (1) fiscal year (FY) 2004 activities; (2) FY 2005 activities for ARS, APHIS, CSREES, ERS and NRCS (first report dated October 2004); (3) FY 2005 activities for the Forest Service (report dated February 2005); (4) FY 2006 activities for ARS/NAL, CSREES, ERS, NRCS and USFS (report dated March 2007); (5) FY 2006 activities for APHIS (report dated August 20, 2007); FY 2006 activities for ARS (report dated September 22, 2007); and FY 2007 activities for APHIS, ARS,ARS/NAL, APHIS, CSREES, ERS, FAS, FS and NRCS (report dated 20 March 2008); FY 2008 activities for APHIS, ARS, ARS/NAL, APHIS, CSREES, ERS, FAS, FS and NRCS (report dated March 3, 2009); FY 2009 activities for ARS, ARS/NAL, APHIS, NIFA, ERS, FS and NRCS (report dated February 17, 2010); and FY 2010 activities for ARS, ARS/NAL, APHIS, NIFA, ERS, USFS and NRCS (report dated 14 March 2011) .

This is the eleventh "USDA Do No Harm Report" to the Invasive Species Advisory Committee and the National Invasive Species Council. It covers the FY 2011 activities for ARS, ARS/NAL, APHIS, NIFA, ERS, USFS and NRCS. The report is dated February 27, 2012.

The report is divided by agency activities. Each agency will report on:

a) Invasive species program activities the agency is carrying out to do no harm;

b) The way in which, when the agency carries out other programs activities, they are also designed and implemented to do no harm;

c) Activities that are doing harm and future actions the agency will take to change the activities so that they do no harm.

Within the above categories, the agency will include its own agency activities, as well as activities where the agency is coordinating and/or collaborating with another federal agency, per the mandate of the Invasive Species Executive Order (EO 13112).

I. USDA Research Agencies:

A. Agricultural Research Service (ARS)

The **Agricultural Research Service** (ARS) Agricultural Research Service (ARS) is the principal in-house research agency of the USDA. With a staff of over 8,000 employees, ARS carries out research at over 100 laboratories throughout the Nation and in several foreign countries. ARS research is organized under four broad categories: Animal Production and Protection; Nutrition, Food Safety, and Quality; Crop Production and Protection; and Natural Resources and Sustainable Agricultural Systems. Pest management, including invasive species, is a major research component across all these areas. Research infrastructure dedicated to pest management includes personnel and facilities in domestic and foreign laboratories that also provide support to other agencies, organizations, and state governments. ARS is committed to performing its research programs and projects in a manner that does not cause or promote the introduction or spread of invasive species in the U.S. or elsewhere, ensuring that all feasible and prudent measures are taken to minimize risk of harm.

1. Activities that do no harm

A. **Informational Activities.**

- **e-Government and Public Communication Initiatives.** USDA's National Invasive Species Information Center (NISIC) at the National Agricultural Library (NAL) maintains and manages the www.invasivespeciesinfo.gov Web site as a reference gateway to invasive species information. The Center and its Web site serve a broad customer base, from students, to farmers, researchers, and government officials. Special attention is given to serve the information needs of the professional media.

- As the resources available through NISIC continue to increase, the site maintains its reputation as authoritative portal for identification of, and access to Federal invasive species resources and activities. The www.invasivespeciesinfo.gov Web site is frequently cited in many news articles as a good source of invasive species information. The Web site consistently is ranked highly in all major search engines and is linked to many invasive species related Web sites (Federal, State, International, and non-profit organizations).

- NISIC maintains a high quality online web presence and provides reference services to a wide variety of stakeholders (local, state, tribal, federal managers, scientists, policy-makers, landowners and land managers, agricultural producers, teachers, students, media journalists, and others).

- In FY 2011:
    - More than 340 requests for information wereanswered .
    - Web Statistics:
        - NISIC Web site -- 4.7 million page views (+57.5% increase from previous year); 1.5 million unique visitors (+68% increase from previous year)
        - NISIC What's New Blog -- 386k page views (+83% increase); 124k unique visitors (+10% increase)
- ITAP Web site -- 90k page views (+120% increase); 14k unique visitors (-3% decrease)

- Responded to various media requests and other patrons for information related to invasive species, including:

- **ABC Producer for an Educational program "Ocean Mysteries" –** producing an episode about invasive species threatening the coral habitats off Georgia and Florida.
- **LA Times Reporter** -- asked for specific information on the economic impacts of invasive insects and was under a tight time deadline.
- **Journalist from Time Magazine** – seeking economic figures for invasive species annual costs.
- **Puerto Rico U.S. Post Office Security Department Employee** -- inquiring if USDA has an invasive or prohibited worms list for packages being sent to the mainland U.S.
- **USDA licensed educational outreach program in Arizona** -- asking for information and regulations regarding importation of raccoon dogs into the U.S.
- **Paralegal Assistant with the Maine State Legislature** – working to enact a catch and kill law in Maine, requested help with finding similar laws in other states.
- **Associate Director, USDA Farm Service Agency, Conservation and Environmental Programs Division** -- seeking contacts that could help the Farm Service Agency evaluate and potentially identify mitigation measures to address invasive concerns about crops that are being proposed for inclusion in the Biomass Crop Assistance Program. Patron needs information for upcoming meeting with his Deputy Administrator.

- FY 2011 NISIC Information Products and Enhancements:
  - **Best Management Practices** -- At the request of John Lydon (ARS National Program Leader), created a new section to address action items included in the National Management Plan (NMP). The new section provides resources and shares Best Management Practices to National Invasive Species Council (NISC) members to prevent or mitigate invasive species establishment or movement. The NMP calls to make taxonomic information more readily available to governments and the public and also to link and expand databases of invasive species pathogens.

- **Twitter** -- Continued using Twitter (InvasiveInfo) incorporating our Invasive News feed and What's New feed automatically, as well as adding custom tweets. At the end of FY2011, InvasiveInfo had 782 followers (+109% increase) with 78 lists (+70% increase) following our Twitter. In many instances, our content was retweeted on our followers' pages. Notable followers include: @NatResources - Nat Resource Cte: Committee on Natural Resources, U.S. House of Representatives; @Interior - US Depart of Interior; @EntsocAmerica - The Entomological Society of America (ESA); @DoDNatRes - DoD NR Program; @NISIPM - New York State IPM; and many others.
- **Social Bookmarking** -- Continued using a social bookmarking widget on our site pages which allows users to easily add pages on our site to various common social bookmarking sites. This utility enables us to monitor additional statistics and extend our outreach. **New Content** -- Frequently added new relevant content for many site topics including: invasive species bills, federal and state press releases, management plans, grants and funding opportunities, conferences and events, education for professionals, specific profiles resources, and much more. Developed new species profiles for current species of interest, such as brown marmorated stink bug, thousand cankers black walnut disease, and others. **RSS Feeds** -- Maintained our customized RSS feeds for What's New on Our site, Invasive Species News, Invasive Species Related Grants (Grants.gov), Invasive Species Journal (Invasive Plant Science and Management),and various Emerging Issues feeds. Hundreds of Subscribers receive our various daily email updates. Subscribers to our email updates include users from many Federal and State agencies, universities and school systems.

- **National Invasive Species Council Support.**
  Continued to support the activities of National Invasive Species Council by posting relevant information and as requested by Hilda Diaz-Soltero, USDA Senior Invasive Species Coordinator (conferences, federal register notices, Invasive Species

Advisory Committee information, etc), as well as additional information from the Federal Agencies representing the National Invasive Species Council.

- **Other e-Government and Public Communication Initiatives.** Invasivespeciesinfo.gov Web site links: USDA's National Invasive Species Information Center Web site links to the 13 Federal Agencies that are members of the National Invasive Species Council, as well as links to the many Agency specific programs and resources relevant to invasive species issues. NISIC also includes extensive resources for State, Professional and Non-Profit, and International programs with an interest in the prevention, control, or eradication of invasive species.

- **Information management support to ITAP**.
  The National Agricultural Library (NAL) provides information management support for the Federal Interagency Committee for Invasive Terrestrial Animals and Pathogens (ITAP), a Federal scientific and technical interagency advisory group. This includes:

  - In FY 2008, NAL launched the www.itap.gov Web site for the interagency committee; NAL continued to support ITAP.gov in FY2011.
  - Supports SharePoint a secure Web-based internal communication platform.
  - Listserv for committee-wide communication.

B. **ARS Research Activities.**

Plant Diseases: Detection, Identification, Characterization, and Monitoring

Phytophthora andina, a species that emerged by hybridization: A new species of Phytophthora, *P. andina*, was described that was identical to the potato late blight pathogen, *P. infestans*, in the sequence data; yet showed a distinctly different host range. ARS scientists in Corvallis, OR, in collaboration with scientists at the University of Florida, clearly demonstrated that *P. andina* is a species derived from hybrid parents *P. infestans* and an unknown

Phytophthora species. This work provides critical insights into a mechanism whereby novel plant pathogens emerge.

Quorum sensing in Brenneria disease of walnut: Microorganisms sense other microbes present in the external environment using a variety of mechanisms. One of the best studied chemical communication systems in bacteria is quorum sensing (QS), a type of intercellular communication which depends on the production of, and response to, low molecular weight inducers in a cell-density dependent manner. ARS scientists in Davis, CA, discovered and characterized a QS system in the phytopathogenic bacterium *Brenneria rubrifaciens* which causes a debilitating disease on walnut trees. They identified the low molecular weight compounds (acyl homoserine lactones) that mediate this communication and demonstrated their ability to facilitate communication between three Brenneria species. Understanding the role of QS in *B. rubrifaciens* is providing insights into the long latency period of this disease which has been poorly understood for decades resulting in ineffective disease control strategies.

New source of resistance to Dutch elm disease (DED); demonstration that *Ulmus americana* (American elm) consists of at least two chromosomal races: The American elm has been decimated across the U.S. by the Dutch elm disease, and efforts are ongoing to develop trees that are resistant to this disease. ARS scientists at Beltsville, Maryland investigated geographical variation in chromosome number in American elm (*Ulmus americana*). While tetraploids are known in nature, the 'Jefferson' variety, released jointly by ARS and the National Park Service is a triploid that shows some tolerance to DED. This indicated that a diploid existed in nature but had not been previously discovered. Plants from throughout the range of the species were examined, and both diploid and tetraploid chromosome races were found in the species. The diploid race was previously unknown, suggesting that considerable untapped genetic variation remains in this species, one of the most important tree species for the American nursery industry. This information will be valuable as efforts continue to develop American elms that are resistant to Dutch elm disease.

Emerging diseases in tomato production: Several emerging diseases have caused serious concerns for the $400 million U.S. greenhouse tomato industry. In addition to the continuing epidemic by the *Pepino mosaic virus* infection, the emerging viroid disease caused by several pospiviroids and a bacterial disease caused by '*Candidatus* Liberibacter solanacearum' have been identified in various greenhouses in the U.S. and Mexico. With the identification of the causal agents in the disease complex, the appropriate disease management strategies may be developed for their control. *Candidatus* Liberibacter solanacearum (Lso) is a fastidious plant pathogenic bacterium which was first identified on greenhouse tomatoes in New Zealand in 2008. Since then, it has been implicated in causing several serious disease outbreaks on solanaceous crops (i.e., potato, tomato, pepper) in North and Central America and most recently on carrot in Europe. Lso was previously identified on field tomatoes in Western Mexico. In the present study, we detected the presence of this bacterium on greenhouse tomatoes in Eastern Mexico. Identification of this bacterium on a different cropping system over a greater geographical distribution implicates that the multi-billion dollar field and greenhouse tomato industries in North America are at risk to this emerging disease

A new bacterial disease of processing tomatoes in the Midwestern U.S.: In 2009 and 2010, outbreaks of bacterial spot characterized by significant leaf and fruit spotting affected at least 2,000 acres of commercial processing tomatoes in northwest Ohio and southeast Michigan, creating losses estimated at $7.8 million. Diseased fruit and foliage were collected from 32 Ohio and Michigan fields in 2010. Although bacterial spot caused by *Xanthomonas campestris* pv. *vesicatoria* commonly causes bacterial spot of tomato, molecular studies and pathogenicity tests conducted by The Ohio State University (OSU) researchers identified the bacterium responsible for the Midwest outbreaks as *Xanthomonas gardneri*. This bacterial pathogen has not previously been reported in either state. ARS scientists have been working with OSU researchers (who are taking the lead on this project) and grower representatives, receiving diseased plant samples from Ohio, and isolating and characterizing the bacterial strains. An ARS scientist from Wooster demonstrated the effectiveness of various sprayers used for disease management to Hirzel Canning growers, an Ohio-based manufacturer of the Dei

Fratelli brand of canned tomato products. ARS remains committed to assisting OSU effort as appropriate. ARS scientists in Charleston have significant knowledge about seed treatments of tomato for disease management, and are looking into this strategy as a path to "clean seeds," which could help to reduce the transmission of this bacterial disease.

Development of an improved method for extraction of total nucleic acids from diverse plant species for new and emerging pathogens: The best strategy to control plant pathogens is rapid identification and detection in quarantine, breeding programs, certification and production. Molecular techniques such as polymerase chain reaction (PCR)-based tests and newer microarray-based tests can be very fast and sensitive in detecting genetic materials (DNA or RNA) of these pathogens. A significant challenge in using these techniques, however, is the ability to prepare plant samples or extracts containing these genetic materials but free of other compounds that occur in plant cells, such as proteins and sugars, that can interfere with the detection technique. ARS scientists in Beltsville, MD have developed a method to extract total nucleic acids from a wide variety of plant material. This method, named the 'CKC' to signify the sequential use of CTAB, potassium acetate (KOAc), and column purification, was optimized for speed and nucleic acid purity in order to facilitate sample throughput. High quality RNA could be purified from all 60 plant species tested, as confirmed by amplification of specific host genes, or, for some virus-infected hosts, amplification of plant virus sequences. This technology will be useful to those who work in quarantine and certification programs that need to test valuable plant material for pathogens by a variety of methods for new and invasive pathogens. The method will also be useful for nucleic acid preparation for research applications, including microarray analysis of gene expression from diverse plants.

Diagnostic reagents for early detection of soybean rust: *Phakopsora pachyrhizi*, the causal agent of Asian soybean rust, has spread from Asia to Africa, South America and finally North America. Since arriving in the U.S. in 2004, the need to use fungicide for control has increased production costs to soybean producers in the Southeast. ARS researchers at Ft. Detrick, Maryland, have developed sensitive, specific antibody-based diagnostic reagents that can identify and

diagnose the disease in soybean leaves before symptoms occur. The diagnostic antibodies have been licensed for production of kits for field detection of the pathogen. Early detection of soybean rust will allow soybean producers to reduce fungicide input costs leading to increased yield and profits.

Reduced-rate fumigant alternatives to methyl bromide for Pacific Northwest Forest Nurseries: The $350 million Pacific Northwest forest nursery has experienced tree seedling losses in excess of 50% in nonfumigated fields due to the presence of soilborne diseases. The fumigant methyl bromide has traditionally been applied to control soilborne diseases, but its use is increasingly limited by state and federal regulations for ozone-depleting agents. ARS researchers at Corvallis, Oregon, evaluated reduced-rate alternative fumigant treatments to methyl bromide for their ability to control soilborne diseases in forest nurseries and found four formulations that were as effective as methyl bromide in reducing disease damage. The results are significant because the alternative fumigant treatments allow growers to continue to manage soilborne diseases as methyl bromide use is phased out, and the ability to use reduced-rates will decrease chemical inputs and result in lower fumigant emissions.

A fungus was identified that controls of Brazilian peppertree in Florida*:* Invasive weeds destroy delicate ecosystems especially in the Florida Everglades National Park. Recently Brazilian peppertree has invaded more than 4,000 acres within the Park. A fungus was discovered that kills the seeds and seedlings of this tree and thus may prove useful in controlling this weed. In addition, the host range of this fungus on related host species was determined. This research will be used by ecologists and plant pathologists working to control this noxious weed tree.

A major monograph of canker-causing fungi was completed: Fungi are a group of organisms that cause billions of dollars damage each year to agricultural and forest resources in the United States. One group of fungi includes fungal species that cause canker diseases on woody plants such as cherry and apple trees. In this research hundreds of specimens and living cultures of three genera of canker-causing fungi from around the world were examined to determine both their macroscopic and microscopic appearance. In addition

DNA sequence data were analyzed to evaluate the limits and relationships among the species. Of the 56 species included, thirteen species are new to science. All species of these three genera are described and illustrated with a key provided for their identification. This research will be used by plant pathologists and plant quarantine officials to identify the fungi that cause diseases on woody plants.

Remediation of *Phytophthora ramorum*-infested soil using biocontrol with *Trichoderma asperellum*: Methods are badly needed to remediate nursery soils that are infested with the Sudden Oak Death pathogen, *Phytophthora ramorum*. Laboratory tests conducted by ARS researchers at Ft. Detrick, Maryland, have demonstrated that the biological control agent, *Trichoderma asperellum*, can reduce P. ramorum soil populations to non-detectable levels within 2 to 4 weeks. They investigated whether *T. asperellum* is able to reduce *P. ramorum* soil populations in a nursery setting. *T. asperellum* was selected and developed into a formulated product that could be applied to larger areas of soil and a research plot was set-up at the Dominican University of California under natural environmental conditions that simulated a commercial plant nursery. Their results showed that *P. ramorum* declined faster in infested microplots treated with the formulated *T. asperellum* isolate than in non-treated control plots and plots treated with commercially-available biological control products. *T. asperellum* thus has the potential to be developed into a commercially available product for control of *P. ramorum*.

Determined the relative susceptability of 50 riparian plant species to infection by Sudden Oak Death determined: As the Sudden Oak Death pathogen, *Phytophthora ramorum*, is found in more and more eastern watersheds, it is necessary to determine what native plant species might be susceptible to root infection by the pathogen, and whether such species might become significant sources of inoculum. Using an assay to quantify inoculum from plants inoculated with *P. ramorum*, ARS researchers at Ft. Detrick, Maryland, were able to test 50 species for susceptibility and inoculum production from roots. They determined that most plants tested were not very susceptible to the pathogen or did not produce great amounts of inoculum from roots, but that certain genera would be good candidates for special scrutiny, including dogwoods, and *Viburnum* sp. This information will be useful for regulatory agencies in developing nursery scouting

protocols and for the Forest Service in performing perimeter surveys of infested nurseries.

Gene expression patterns in rust resistant soybeans: Soybean rust is a serious foliar disease caused by the pathogen *Phakopsora pachyrhizi* that can drastically reduce yields due to premature leaf drop and lower seed set and weight. ARS researchers at Ft. Detrick, MD, in collaboration with scientists at Iowa State University and the ARS Corn Insect and Crop Genetics Research Unit at Ames, Iowa, monitored the expression of approximately 37,000 genes in a soybean line containing the rust resistance gene *Rpp3*. Results showed a dramatic increase in gene expression at 12 and 48 hours after infection with *P. pachyrhizi* that correlated with the formation of specialized infection structures. The genes identified in this study are candidates to investigate for a functional role in resistance and will useful to government, academic and private sector researchers and breeders developing rust resistant soybean cultivars.

Genomic sequences of seven plant-associated strains of *Pseudomonas* spp. reveal potential new determinants of biological control: Biological control is a promising approach for management of plant diseases, but knowledge of biocontrol mechanisms is needed to improve its reliability for US agriculture. Towards this end, ARS scientists in Corvallis, OR, Pullman, WA, Davis, CA, and Charleston, SC, with colleagues at Macquarie University and the J. Craig Venter Institute sequenced the genomes of seven well-characterized biological control strains of *Pseudomonas* spp. (*P. fluorescens, P. chlororaphis* and *P. synxantha*). Through comparative genomic analyses, they identified approximately 2800 genes that are shared by all strains and 300 to 900 genes that are unique to each strain. In the unique regions of each genome, they discovered new gene clusters with potential roles in biological control, including those coding for insect toxins and new secondary metabolites. These gene clusters provide avenues for the future discovery of novel natural products, including those contributing to biological control of plant disease.

Insects: Detection, Identification, Characterization, Monitoring, and Control

Resistance of hemlock to the woolly adelgid bug: The hemlock woolly adelgid (*Adelges tsugae*) is killing hemlock trees faster than expected in the southern Appalachians, and rapidly altering the carbon cycle of these forests. It is a true bug native to East Asia that feeds by sucking sap from hemlock trees (*Tsuga* spp.). In eastern North America, it is a destructive pest that poses a major threat to the eastern hemlock (*T. canadensis*) and the Carolina hemlock (*T. caroliniana*). Few options are available for control of this pest. ARS scientists at the National Arboretum in Washington, D.C., have begun a long-term breeding program aimed at the development of disease-tolerant and pest-resistant urban trees has made progress in several genera. Elite clones of hemlock from interspecific crosses that demonstrate resistance to the woolly adelgid have been propagated for increase and distribution to nursery collaborators.

Discovery of ten new species for biological control: Invasive species cause hundreds of billions of dollars in losses in the United States each year. ARS scientists conducted extensive field explorations in search of natural enemies of invasive target pests in their native land. During these explorations a number of organisms are usually collected for testing as potential candidates for biological control of the invasive target pests in the United States. Prior to the testing process, the accurate taxonomic identification of the natural enemies by classical procedures and/or more sophisticated molecular methods is a key aspect for the success of the projects. During extensive field explorations in FY 2011, ARS scientists at the South American Biological Control Laboratory (SABCL) in Argentina discovered 10 species of insects new to science: one natural enemy of waterhyacinth, Brazilian water weed, waterprimrose, cactus moth, and Parkinsonia weed; four of the cactus mealybug; and one ant species closely related to the target little fire ant. Some of these new species have been described and named by expert taxonomists with close collaboration of SABCL scientists. Descriptions of the remaining ones are in progress. These accomplishments will greatly increase the chances of success of the respective biological control programs in the United States and will contribute to the knowledge of the biological diversity in Argentina and globally.

Insect and mite systematics protect the Nation's agriculture: Invasive insect and mite species cause hundreds of billions of dollars in losses

in the United States each year. During the past year, ARS scientists in Beltsville, Maryland, completed and/or published descriptions and enhanced collections of insects and mites that include species of flies, beetles, leaf rollers, parasitic wasps, aphids, plant bugs, and mites. Many of these represent groups that are or have potential to be invasive in the U.S., while other groups are insect or plant predators that are known or potential biological control agents. These newly developed and previously existing collections and identification tools developed by ARS were used in 31,000 identifications, many of which were from specimens collected at U.S. ports and submitted by APHIS as "urgent." As a result of these identifications, a number of shipments were prevented from coming into the U.S. or sanitized before they were allowed to do so, thus protecting U.S. agriculture from new insect and mite invasions. In addition, biological control researchers are using the knowledge gained from the insect and mite descriptions to improve their ability to discover natural enemies of common and invasive plant pests.

Improved (cotton) boll weevil detection method enhances eradication program: Although the boll weevil, *Anthonomus grandis*, has been eradicated in most of the U.S. Cotton Belt, complete eradication has not been achieved because the insect can overwinter in remote areas of the southern and central regions of Texas where winter conditions are mild. Consequently, progress towards complete eradication of boll weevils from these areas depends upon better weevil detection with pheromone traps used to determine when and where insecticide applications are needed. ARS researchers observed that substantial weevil infestations were going undetected, even in known infested areas. ARS scientists in College Station, Texas, discovered that a substantial proportion of lures used in pheromone traps in this region contained an insufficient dose of pheromone, and that a single weevil can release significantly more pheromone than previously thought. This discovery led ARS researchers to recommend protocols of doubling the lure quantity and decreasing the lure replacement interval, which were immediately adopted by the Texas Boll Weevil Eradication Foundation. The Adoption of these protocols significantly improved the eradication progress in a chronically boll weevil-infested eradication zone, which helped to protect major advances achieved through the multi-billion dollar investment to eradicate the boll weevil from the United States

Fusion of remotely sensed data enhances field detection of cotton plants: Aerial and ground-based remotely sensed data can be used to detect both different types of vegetation and the vigor/health of this vegetation over large areas. However, new techniques are needed to improve the capability of accurately discriminating between cotton plants and other crop types, given issues with wild/volunteer cotton and cotton pest management programs, such as the ongoing Boll Weevil Eradication Program. ARS researchers in College Station, Texas, acquired airborne and ground-based spectral reflectance data over three large agricultural fields in central Texas. Accurate discrimination between cotton plants and other crop types was achieved by analyzing independent aerial and ground-based datasets and combined datasets, using a multi-sensor data fusion technique. Crop type classification accuracy of remotely sensed data acquired by the aerial and ground-based sensors was approximately 90 percent, but improved to greater than 99 percent by using the data fusion technique. This research has achieved great accuracy and reliability in detection of growing cotton, and will be of major benefit in supporting the Boll Weevil Eradication Program by detecting plants that harbor weevils that would otherwise go unnoticed and untreated.

Epidemiology and management of zebra chip disease and its vector: Zebra chip disease of potato is causing millions of dollars in losses to the potato industry. The disease is caused by a new species of the bacterium *Liberibacter*. ARS scientists in Wapato, Washington, determined that zebra chip disease is transmitted by the potato psyllid and that high temperatures during the potato growing season prevent development of the bacterium and the disease. The scientists also determined that zebra chip-infected potato seeds do not germinate, thus the disease could not spread through the distribution of potato seeds. Their research also led to the identification of potato breeding lines that show some resistance to zebra chip disease. The results of this research improve our understanding of zebra chip disease epidemiology, benefit potato seed certification agencies, promote national and international trade of potato seed, and facilitate development of effective management strategies for this serious disease.

New bait for monitoring and control of spotted wing drosophila, a pest of soft fruits: The spotted wing drosophila is a new invasive pest of soft fruits in the United States and is a serious threat to growers of berries and cherries in the Pacific Northwest. Unlike most drosophila species which only attack rotting fruits, this drosophila species attacks healthy young fruits, making it a serious invasive pest. Traps are used to detect its presence and determine the need for pest control measures. ARS scientists in Wapato, Washington, developed and demonstrated an improved lure formulation that is a combination of vinegar and wine. This information can be used to improve the efficiency of traps for the spotted wing drosophila and possibly lead to synthetic chemical lures derived from the critical components of vinegar and wine that are involved in their attraction to this invasive and costly pest.

Sequencing the Russian wheat aphid genome and elucidating aphid salivary proteins to discover sources of pest resistance: Russian wheat aphid continues to be a destructive pest of wheat and barley in the United States. The genomes of Russian wheat aphid biotypes 1 and 2 were sequenced by ARS scientists in Stillwater, Oklahoma, and a draft assembly completed. Salivary proteins common or unique among biotypes of Russian wheat aphid and greenbug were identified. More than 30 salivary proteins of Russian wheat aphids were identified that will be valuable in developing RNAi gene silencing technology to create new resistance genes to protect plants from Russian wheat aphids or other sucking insects.

Novel banker plant system for biological control of silverleaf whitefly in horticultural crops: Silverleaf whitefly is a pest and virus vector of vegetable and ornamental crops worldwide. ARS researchers in Fort Pierce, Florida, in collaboration with researchers at the University of Florida developed a novel “banker” plant system for the management of the silverleaf whitefly. Papaya plants with fruits infested with papaya whitefly served as rearing material for a parasitoid wasp that also attacks the silverleaf whitefly. By introducing the papaya “banker” plants loaded with wasps into the greenhouse before any pest whiteflies are detected, the wasps act as sentries and attack whiteflies that would otherwise become established in tomato crops. This results in successful greenhouse tomato production without the use of pesticides. This system has broad application for protection of

horticultural crops and has also been used successfully in commercial herb, cucumber, eggplant, lettuce and poinsettia greenhouses in Florida.

Ovicidal and neonate activity of insecticides demonstrated for navel orangeworm: Almonds are the largest California nut crop, with greater than 1.7 billion pounds produced annually. However, production and nut quality can be severely affected by the navel orangeworm (NOW) caterpillar. Insecticide controls for NOW moth eggs and larvae had not been established for newly registered insecticides in almonds. ARS researchers in Parlier, California, showed that two new classes of insecticides, anthranilic diamide and diacyl hydrazine are toxic to NOW eggs and newly hatched larvae, with up to a 97 percent kill rate. Their use will replace broad spectrum insecticides and they are compatible with pheromone-based strategies that disrupt moth mating. As these new insecticides have ovicidal activity and are more selective than broad spectrum insecticides currently used, their use would result in improved NOW control with reduced non-target effects.

Research improves in vivo rearing of nematodes on mealworm beetles, for pest control: The mealworm beetle, *Tenebrio molitor*, is used for mass production of nematodes that kill pest insects. Efficient rearing of the mealworm beetle is important for producers of the nematodes to have a profitable business and to produce enough nematodes for the needs of customers. ARS scientists in Stoneville, Mississippi, developed six mealworm beetle diet formulations that significantly improved immature mealworm beetle survival, development time, food utilization efficiency, and reproductive potential. Two of these formulations increased the beetles' susceptibility to infection by two species of nematodes and resulted in higher nematode yields. The results from this research will result in increased yields and cost savings in the production of beneficial nematodes that utilize mealworm beetles, which in turn will lead to lower pesticide usage.

Japanese beetles, a key pest of horticultural crops, paralyzed by a chemical from zonal geranium: The Japanese beetle is a highly destructive plant pest that can be very difficult and expensive to control. Adults attack the foliage, flowers, or fruits of more than 300

different ornamental and agricultural plants. Zonal geraniums have been known since the 1920s to be toxic to Japanese beetles; however, until recently the chemical responsible for the toxicity remained unknown. ARS researchers in Wooster, Ohio, isolated and identified quisqualic acid from flower petals of zonal geranium and demonstrated its role in paralyzing adult Japanese beetles. This discovery will provide a new line of plant-derived and synthetic chemical controls for Japanese beetles and possibly many other important insect pests.

Wheat stem sawflies more susceptible to attack than previously believed: Wheat stem sawflies attack wheat stems in the northern Great Plains, living inside the stem, lowering seed production and quality, and eventually cutting the stem so that the wheat falls over making it difficult to harvest. It was previously thought that after the stem was cut, few of the sawflies were attacked by parasitic wasps that lay eggs through the wheat stem wall. ARS researchers in Sidney, Montana, examined rates of late season parasitism of wheat stem sawflies by native species of wasps and found that rates of parasitism in wheat stubble chambers reached a maximum of 46 percent, greatly exceeding the previously reported maximum of 2.5 percent. In contrast with previous work, ARS researchers' results demonstrated that larvae of wheat stem sawfly are suitable hosts for parasitic wasps, even after the formation of overwintering chambers in wheat stubble; this suggests that parasitism rates have likely been seriously underestimated in sampling stems prior to harvest, as is typically done. This research demonstrates that native wasps may have greater potential as a biological control for wheat stem sawflies than previously believed.

Demonstrated change in host specificity of biological control agent: Evolutionary shifts in host specificity of insects introduced for biological control of foreign pests could affect non-target native species. While the likelihood of such evolution is considered low, few experiments have been done to determine just how likely such a change in host specificity would be or under what conditions it would occur. ARS researchers in Newark, Delaware, found that a parasitoid wasp, *Aphelinus* near *Gossypii*, that is a candidate for introduction for control of soybean aphid, showed a rapid response to selection for parasitizing a seldom attacked aphid species. This demonstrates

that, under laboratory conditions, evolution of the specificity of a biological control agent can be rapid. Although this host shift response observed under laboratory conditions is unlikely to occur in the field, understanding the role of genetics in such an event will help inform regulators on the safety of releasing biological control agents into the environment.

Improved fermentation process for biological insecticide: Biological control of insect pests are often the preferred or only control option, as in cases where insects have developed resistance to chemical insecticides or chemicals are not recommended because of environmental or safety concerns, as in urban and aquatic environments or organic farming. *Isaria fumosorosea* (Ifr) is a naturally-occurring fungus that produces spores that can infect and kill soft-bodied insects such as whiteflies, aphids, and subterranean termites. Liquid fermentation processes for the production of spores of Ifr has been known for many years, but high production costs remain a major constraint to the use of Ifr as an insect control agent. ARS scientists in Peoria, Illinois, have developed a lower-cost production medium for spores of Ifr and identified environmental conditions during fermentation that promote the production of spores rather than the filamentous form of the fungus. These improvements resulted in an 80 percent reduction in the cost of the production of nutrients and a significant reduction in product processing requirements. The improved production process resulted in yields of over one trillion spores per liter of fermentation broth after a short fermentation time of 40 hours. Discussions are under way with an industrial partner on the commercialization of this and other ARS technology related to the production and use of Ifr for insect control. This Ifr production process could result in the expansion of the use of this lower-cost insect biological control agent by farmers, greenhouse operators, and homeowners.

Influence of alpha-pinene on attraction of ambrosia beetles to ethanol-baited traps: Certain species of ambrosia beetles are increasingly recognized as pests of ornamental nursery trees. Ethanol is the most attractive compound known for these beetles and is commonly used in traps for monitoring purposes. In order to optimize monitoring and detection programs, field-based trapping experiments were conducted to assess the influence of alpha-pinene

on attraction of ambrosia beetles to ethanol-baited traps. Alpha-pinene increased the attraction of certain ambrosia beetles to ethanol, but reduced the attraction of other species. These experiments demonstrate that traps baited with ethanol alone and a combination of ethanol and alpha-pinene are useful for monitoring and detecting ambrosia beetles in ornamental nurseries. This information will help refine monitoring techniques that enable growers to synchronize their control treatments with ambrosia beetle activity.

Landscape level dynamics of plant bugs in cotton: Lygus bugs affect multiple crops in arid-land agricultural systems and are major pests of cotton in the western United States. ARS scientists in Maricopa, Arizona, in collaboration with scientists at the University of Arizona and the University of California, developed predictive methods for estimating lygus abundance in cotton fields based on the area of cotton planted, nearby uncultivated habitats, and seed alfalfa growing within 2.75 m of the cotton field. This provides growers with valuable information on how they can manipulate the planting of various crops on their farms and potentially cooperate with neighboring growers to reduce the presence and impact of pest insects regionally.

Insect-pathogenic fungi used to control Asian ambrosia beetles, pests of nursery and landscape trees: Asian ambrosia beetles are serious pests of nursery and landscape trees. Beetles cause both cosmetic and systemic damage and are difficult to control. ARS researchers in Ithaca, New York, tested three commercially available strains of insect-pathogenic fungi against field-collected and laboratory-reared ambrosia beetles. Of the three commercial fungal strains tested, *Beauveria bassiana* Naturalis and *Metarhizium brunneum* F52 were more virulent than *B. bassiana* GHA against ambrosia beetles. For all three strains, depending on dosage, the number of offspring produced was reduced and infection was observed among larvae, pupae and adult progeny, causing additional mortality and spread of the fungus. These results demonstrate that exposure to available microbial control agents can have a significant impact on ambrosia beetle survival, and the potential of these strains in an integrated ambrosia beetle management program.

Potato psyllid integrated pest management improved: The Lower Rio Grande Valley has consistently been found to have the highest levels

of potato psyllid [*Bactericera cockerelli* (Sulc)] infected with "*Candidatus Liberibacter solanacearum,*" the putative causal agent of zebra chip disease in potatoes. Scientists in Weslaco, Texas, working with collaborators from across the Great Plains, have developed a regional sampling and control plan for the potato psyllid and the zebra chip disease that it vectors. In this program, the results of weekly sampling and pest management measures were transmitted to growers and private consultants from January to October of 2011. Growers were alerted when infested potato psyllids were detected so that timely applications of pesticides could be made. The sampling protocol used proved effective in detecting zebra chip infested psyllids. The study demonstrated that by controlling the zebra chip infested pest at the time of planting and shortly after, the zebra chip disease in tubers at harvest was significantly reduced. This management plan, which was developed for the Lower Rio Grande Valley by scientists in Weslaco, has been adopted by more than 90 percent of the growers in the Great Plains that are impacted by zebra chip.

New environmentally friendly options for control of citrus pests based on insect pheromones: Originating from Asia, the citrus leafminor (*Phyllocnistis citrella*) is now a major pest of citrus grown in California, Florida, and Texas. Economic losses result from insect damage, disease transmission, and increased pesticide use. ARS entomologists in Fort Pierce, Florida, in collaboration with the University of Florida and private industry are developing new products based on insect pheromones for control of major citrus pests and diseases and new methods for their application in commercial citrus groves. Recently they developed a formulation, SPLAT-CLM™ (ISCA Technologies, Riverside, California) based on the citrus leafminer (CLM) pheromone to disrupt mating of this pest in citrus orchards. As SPLAT-CLM™ is a highly viscous material, ARS scientists worked with International Fly Masters, Inc. to develop an effective system to deliver the product that uses global positioning system telemetry to assure accurate placement and application rate. Another version of the product, MalEx™ (AlphaScents Inc., Portland, Oregon) contains a pesticide that is fatal to the male CLM moths attracted to the lure. SPLAT-CLM™, is now available commercially, while availability of MalEx is pending EPA registration. These products will contribute to reduced losses to leafminer damage and

citrus canker disease as well as reduced dependence on traditional pesticides.

Establishment of a new exotic olive fly natural enemy in California: Since the discovery of olive fruit fly in California a decade ago it has become the most important olive pest; it threatens the economic viability of the U.S. olive industry. Scientists at the ARS European Biological Control Laboratory conducted explorations for effective natural enemies of the fly in Africa and Asia. A number of agents obtained by these scientists have been evaluated by cooperators in California during the past several years, and APHIS has permitted several of these species for field release. This year, after several consecutive years of releases, surveys documented the establishment of one of these agents, the parasitic wasp *Psytalia lounsburyi*. This is the first successful establishment of an exotic natural enemy of olive fly from the fly's native range in Africa into new regions where olive is now cultured. It is anticipated that this parasitoid wasp will eventually cause significant reductions in olive fly populations as it spreads throughout Californian olive groves.

Insect Pest Management for thrips and tospoviruses in tomato crops: Thrips and thrips-vectored viruses are among the most serious pests of vegetable, ornamental, and agronomic crops in Florida. ARS scientists in Tallahassee, Florida, in collaboration with scientists at the University of Florida, developed a set of guidelines for growers to effectively manage thrips and thrips-transmitted viruses in tomato crops. These guidelines are based on the use of realistic economic thresholds, scouting and identification of thrips species, conservation of non-pest thrips that out-compete pest species, the use of ultraviolet reflective mulch, the avoidance of insecticides that induce western flower thrips populations, and vertical integration of management of western flower thrips with other pests, including whiteflies and Lepidopteran pests. These recommendations are being adopted by growers, leading to reduced pest pressure with lower insecticide use and improved yields.

Absolute configuration and synthesis of 7-epi-sesquithujene for biological control of emerald ash borer: Emerald ash borer, *Agrilus planipennis*, is an invasive Asian pest that threatens all native ash tree (*Fraxinus*) species. One promising candidate attractant for this

pest, the plant volatile 7-epi-sesquithujene, stimulates odor reception of both male and female emerald ash borer. ARS researchers in Peoria, Illinois, determined the spatial arrangement of atoms of 7-epi-sesquithujene, which is necessary for its effective and economical synthesis. Another pheromone was discovered that attracts females of the emerald ash borer's natural enemy, a wasp named *Spathius agrili.* Since this wasp is being released as a control agent throughout the range of emerald ash borer, the pheromone will be a useful tool for locating the wasp to be sure it is doing its job. The ability to attract both emerald ash borer and its natural enemy will make biological control of the invasive insect more precise and effective.

Progress in controlling the invasive Argentine cactus moth in the United States and Mexico: Subsequent to its detection in south Florida in 1989, the Argentine cactus moth expanded its range 50-100 miles per year along the Atlantic Coast and west along the Gulf Coast to the barrier islands of Mississippi and bayous of Louisiana and now poses an imminent threat to many *Opuntia* cactus species in the United States; species valued for food, forage, and wildlife habitat; their ecosystem structure; and their biodiversity. ARS researchers in Tifton, Georgia, and Tallahassee, Florida, collaborating with APHIS, improved control tactics using field sanitation combined with sterile insect releases along the leading edge of the invasion and at new outbreak locations. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca Y Alimentación, Mexico is implementing these tactics in the U.S.-Mexico bi-national campaign against Argentine cactus moth. Following the successful eradication of cactus moth from islands off the coast of Quintana Roo, Mexico, these tactics have contributed to the further reduction of established populations of this pest on the Mississippi and Alabama barrier islands, in Louisiana bayous, and along the northwest Gulf coast of Florida, mitigating the further westward expansion of pest populations along the Gulf of Mexico.

Identification of pheromone receptors in moths: Semiochemicals are used for monitoring and controlling numerous moth pests, including the codling moth in apple and pear orchards. Understanding the biochemical basis of detection of these chemicals provides avenues of research to discover and develop novel analogs disruptants,

attractants, and masking agents. A technique was developed by ARS scientists in Wapato, Washington, to identify odorant receptors expressed by codling moths, and the technique was then used to identify many odorant receptors in a variety of other moth pests of agricultural crops. This technique is much faster and less expensive than previous efforts and facilitates the development of assays for identifying the corresponding ligands that might be useful in managing moths and other pests.

Susceptibility of small fruits to spotted wing drosophila determined: The spotted wing drosophila is a new invasive fly that is threatening the small and stone fruit industry, particularly in the western states. Unlike other drosophila flies, this species can infest undamaged fruit that is still on the plant leading to rejections of harvested fruit. ARS scientists in Corvallis, Oregon, with collaborators at the University of California and Oregon State University, have determined that small fruits and cherries were mainly susceptible to spotted wing drosophila at the color-changing stages, no cultivars appeared strongly resistant, and table and wine grapes were not as susceptible based on laboratory assays. This information is now published, and has been used to refine management guidelines in 2011 for timing control treatments.

New genes for lethality in fruit flies: Mass releases of sterile males is a widely used means to control pest fruit flies, but the radiation that sterilizes males often damages their sexual performance. Conditional-Lethality, where a released insect's offspring die when certain environmental conditions prevail, is a promising substitute for traditional sterility. A successful conditional-lethality strain for the Caribbean fruit fly was created that survives on a diet supplemented with an antibiotic, tetracycline, but suffers 100 percent embryonic lethality in the absence of the antibiotic. The genes involved will serve to improve the efficacy of control programs that protect U.S. agriculture from not only fruit flies but also from other potentially invasive insect pests.

Defeating termites: The Formosan subterranean termite was introduced into the US in the 1940s and proceeded to spread throughout much of the Southeast from Texas to Georgia. It is a particularly destructive termite that can live in the ground or in nests it

constructs within structures. USDA ARS has conducted research on new ways to control this termite and on how to form a strategy for community control. Although the termite continues to spread widely in the South, this program has conclusively demonstrated that an integrated pest management program against the termite can be very effective. The demonstration project saved the French Quarter of New Orleans from destruction by achieving 95% control of the termite, as measured by the disappearance of colonies from individual buildings and public spaces. The techniques used to achieve this level of control were based on a wide range of studies, including how termites develop to specialized forms, identification of individual colonies by their genetic signatures, invention of new kinds of monitoring and bait stations, detection equipment based on sound and infrared, and novel methods of treating living trees. In the course of this project, new classes of insecticide were developed, the complete genome of the termite was sequenced, and novel enzymatic pathways for energy production were discovered. The efforts of the USDA ARS research program on termites can be credited with most of the development of modern termite control in the United States, protecting structures effectively without the negative environmental consequences of older treatment methods.

Reducing the worldwide threat of invasive fire ants: The red and black fire ants were introduced into the United States during the early part of the 20th Century, eventually infesting 14 states in the Southeast and California. They have multiplied to dense populations wherever there is water, destroying pasturage and threatening livestock and humans with their biting and stings. Extensive genomic studies, including sequencing and annotation of the complete genome, have been helpful in a number of ways. First, the origin and subsequent movement of red fire ant populations were described, showing a pattern of introduction, adaptation, and subsequent onward movement of populations preadapted for invasive characteristics. Examination of the genome revealed hidden viral sequences, resulting in the discovery of the first viruses in any ant species. The third virus was found this year and is distinctive in being a DNA virus and very lethal on the ant. The genomic sequence was also used to developed inhibitory RNA (RNAi) constructs that kill entire colonies based on disruption of one of two genes. A single feeding of these preparations was sufficient to destroy a colony in the laboratory. This

is the first proof of concept for the utility of an RNAi insecticide, a concept developed by USDA ARS. Such insecticide would be highly specific for fire ants, leveraging the efforts of native species of ants to compete with the invasive fire ants. Combined with established methods of biological control (insects and pathogens that kill fire ants), these new methods will contribute toward restoring ecological balance where fire ants currently reach an abundance not experienced in their native range. Such success in biological control would reduce the use of insecticides and improve productivity of pasture in the Southeast.

Brown Marmorated Stink Bug Working Group: ARS researchers in Kearneysville, West Virginia, initiated formation of the Brown Marmorated Stink Bug (BMSB) Working Group. This group brings together research personnel from USDA, ARS and Land Grant Universities from over 10 states as well as extension personnel, stakeholders, industry representatives, and regulatory officials from the USDA, APHIS and the EPA. This group has formulated research, extension, and regulatory priorities for the BMSB and developed coordinated, collaborative projects aimed at developing effective monitoring and management tools for this invasive species.

Fifth backcross generation grapevines were created for the development of Pierce's disease resistant raisin and table grapes: All table and raisin grapes grown in California are susceptible to Pierce's disease caused by the invasive pathogen *Xyllela fastidiosa*. ARS scientists at Parlier, CA have generated fifth backcross generations of table and raisin grapes combining Pierce's disease resistance from *Vitus arizonica* with fruit quality from advanced table and raisin selections. The fifth generation progeny have an average of 98.4% *V. vinifera* background for high fruit quality, yet retain the Pierce's disease resistance gene PdR1 from *V. arizonica*. This germplasm may be developed into table and raisin grape varieties that can be grown in areas with high incidence of Pierce's disease.

Molecular mechanism of Xylella fastidiosa PemK toxin determined: The PemK/PemI toxin/antitoxin confers stability of inheritance of plasmid DNA in the invasive pathogen *Xylella fastidiosa*. ARS scientists at Parlier, CA determined that PemK toxin is an enzyme that degrades cellular RNA, thereby killing bacterial cells that do not

inherent plasmid expressing the PemI/PemK system. Improved understanding of the PemK toxin mechanism has facilitated development of a gene shuttle vector for stable delivery of foreign DNA to *X. fastidiosa* for use in genetic analysis of pathogenicity.

Comparative genome analysis of 'Candidatus Liberibacter' species causing citrus Huanglongbing (HLB) and potato Zebra Chip (ZC) diseases: The genomes of the presumptive pathogens causing HLB ('Candidatus *Liberibacter asiaticus'*) and ZC (Candidatus *Liberibacter solanacearum'*) diseases are incompletely characterized. ARS scientists at Parlier, CA conducted a comparative genome analysis of these two unculturable, fastidious bacteria. Genomic and metabolic pathway analyses revealed that the two bacteria encode 884 common genes representing 65% of the genome. The remaining 35% of the two genomes were divergent, with a significant number of genes coding for membrane and transport functions that reflect the corresponding pathogenic lifestyle of these bacteria. This genomic analysis provided basic knowledge needed for functional analyses of 'Ca. *Liberibacter*' genes involved in pathogenicity and will facilitate identification of new targets for development of disease resistance.

New product that controls bee mites with acids from hops: *Varroa* mite is the most important invasive pest of honey bee colonies and causes major colony losses due to parasitism and transmitting viruses, many of which are associated with Colony Collapse Disorder. Beekeepers need new methods to control *Varroa* mites because currently registered products are either inconsistent in their effectiveness, harmful to brood, contaminate wax combs, or no longer control *Varroa* mites because the mite is resistant. Under a Cooperative Research and Development Agreement, ARS scientists in Tucson, Arizona, developed a product (commercialized as Hopguard™ by BetaTec Hop Products) that uses beta plant acids from hops to reduce varroa mite populations in colonies. A Section-18 emergency registration was issued by EPA and HopGuard™ is now in commercial production and being used in honey bee colonies.

Controlling the key parasite of honey bees, Varroa destructor, through genomics: Novel controls based on genomics will provide for strong control of the invasive parasitic mites of honey bees, *Varroa destructor*, while reducing the use of chemicals. A draft genome

sequence was published for this mite, revealing potential weak points in its biology (defensive proteins and proteins used in chemical mitigation) and candidates for novel controls such as RNA interference (RNAi), a method for knocking down specific pest proteins. The description of mite candidate genes allowed the worldwide initiation of RNAi-based control efforts for this parasite; with the first successful demonstration of RNAi activity in *Varroa* in late 2010

Tools developed for tracking and understanding Colony Collapse Disorder: Efforts to improve bee health have suffered from an inability to accurately assess disease caused by viruses and other pathogens. ARS scientists in Beltsville, Maryland, have improved methods for collecting honey bees from representative populations, shipping them for genetic analyses, stabilizing and extracting RNA, conducting high-throughput genetic screens for invasive viruses and other pests, collecting embryos from established colonies, and carrying out controlled experiments on adult bees. These methods are being used in national surveys in the United States in order to establish cell lines and other genetic techniques and to better determine interactive effects

Genes associated with Nosema infection determined by microarrays: In 2010, researchers in Weslaco, Texas, verified the infection status of bees infected with the invasive parasite *Nosema* using DNA and microarray approaches. Microarray analyses revealed that, as expected, *Nosema* infection alters bee biological processes regulating nutrition and behavioral maturation, but surprisingly infection does not appear to significantly alter immune gene expression in midgut and fat body tissues up to 7 days post-infection. ARS scientists will continue to examine impacts of infection by characterizing gene expression in immune-related tissues up to 2 weeks post-infection in bees infected with *Nosema*. These studies identify host response to *Nosema* infection and will lead to downstream applications in commercial management, improving the strength of the honey bee colonies.

Russian honey bee genes predominant in a feral population of honey bees: Because of the ravages of the invasive parasite *Varroa destructor,* feral populations of honey bees have almost disappeared.

Feral honey bees are major pollinators of many plants in a variety of ecosystems so their loss has led to a critical shortage of naturally occurring pollinators. ARS scientists in Baton Rouge, Louisiana, have determined that a feral population of honey bees has developed near Russian apiaries which have *Varroa* resistant honey bees and that it is predominantly Russian in parentage. This observation suggests that feral populations of honey bees will rebound in areas that have beekeepers that use *Varroa* resistant stock.

Weeds: Detection, Identification, Characterization, Monitoring, and Control

Molecular genetic markers for medusahead: Medusahead (*Taeniantherum asperum*) is an invasive annual grass that threatens grazing and grasslands in the western United States. As it is closely related to wheat, ARS scientists in Reno, Nevada, have adapted existing simple sequence repeat markers that were developed for wheat breeding studies as new genetic markers to characterize different races of medusahead. Using PCR primers designed from these new genetic markers and DNA from medusahead samples collected from different geographical regions, the scientists were able to differentiate populations of this weed based on sequence differences of the amplified DNA. This new knowledge is of value to scientists in identifying the most appropriate geographical regions to search for natural enemies to control this invasive weed.

Unlocking the regulation of the production of bacterially produced herbicides: A major challenge in the use of chemicals to control invasive weeds is the limited number of available modes-of-action of these chemical herbicides. Many phytotoxins produced by bacteria, particularly *Pseudomonas syringae* strains, have modes-of-action unlike those of commercial chemical herbicides, however, production levels of these natural herbicides is currently insufficient to warrant their commercialization. Using molecular genetic approaches, ARS researchers in Beltsville, Maryland, in collaboration with molecular biologists at the University of Nottingham, United Kingdom, showed that the overproduction of the regulatory protein RsmA, a natural protein produced by Psuedomonads, turns off phytotoxin production in three unrelated strains of *P syringae*. This is the first demonstration of the role of RsmA in the production of phytotoxins in

P. syringae. These results suggest that overcoming the RsmA regulatory system will provide a way to improve phytotoxin production by this group of bacteria to commercially acceptable levels and/or improve the bio-herbicidal activity of *P. syringae* strains that may be useful in the biological control of invasive weeds.

Arundo armored scale released for biological control of Arundo donax, a waterway clogging invasive giant reed grass: The non-native, invasive giant reed grass *Arundo donax* has invaded at least 100,000 acres in the arid Lower Rio Grande Basin. It consumes water supplies and reduces access to the international border which is critical for national security. Biological control of this weed is critically needed, because other control methods are not economically or environmentally feasible. In 2011, ARS researchers in Weslaco, Texas, released over 3 million Arundo scale insects along the Rio Grande River, and establishment has been documented at all release sites. This research and the resulting biological control program address the national research priority to protect scarce water resources for agriculture in the context of climate change, which is expected to increase drought length and severity in the Lower Rio Grande Basin. Information on the field biology of the scale is useful for researchers and land managers in other areas where Arundo is invasive.

Cell division regulates dormancy in root buds of leafy spurge: Perennial weeds, such as leafy spurge, are particularly problematic in conventional and organic farming system and ranchlands as they can spread from hundreds of buds on root or underground shoot systems. In addition, perennial weeds often escape control measures by regrowing from underground buds that were not targeted by the treatments. Knowing that dormancy is ultimately caused by blockage of cell division, ARS researchers in Fargo, North Dakota, investigated an important plant cell division protein called CDKF in buds of leafy spurge. The researchers discovered a site in this protein to which phosphate molecules can be added and determined that the phosphorylated form of the protein is crucial in the formation of complexes with other cell division proteins that are involved in the release of buds from dormancy. This new knowledge may lead to a new control strategy based on simultaneous bud dormancy release that could significantly improve control methods of perennial weeds.

Control of invasive Russian olive for habitat restoration: Russian olive is an invasive tree species in the west. The invasion decreases landscape productivity by reducing forage value and negatively impacting hunting and recreation. As part of a multi-government agency and regional land manager effort to restore habitat invaded by Russian olive, ARS researchers in Sidney and Miles City, Montana, in collaboration with USDA Natural Resources Conservation Service (NRCS) and the National Wild Turkey Federation, investigated best practices for Russian olive control. They determined that shearing the trees, immediately followed by application of triclopyr formulated with basal bark oil was effective in preventing the destroyed trees from resprouting. This cost effective methodology is now recommended by the NRCS and Dow Chemical for the control of Russian olive prior to restoration efforts.

Animal Diseases: : Detection, Identification, Characterization, Prevention, Monitoring, and Control

New tools to control the cattle fever tick: The two species of cattle fever tick were eliminated from the United States during a campaign of systematic cattle treatment across the southern United States from 1912 through 1943. A strict system of quarantine along the southeastern border between Texas and Mexico has prevented the ticks from reinvading the country, virtually eliminating the threat of bovine babesiosis. The increase in white-tailed deer populations and the presence of significant populations of feral exotic ungulates have created a situation that challenges the previous methods of control. White-tailed deer, especially, reintroduce the ticks into pastures that either have no cattle or that have treated cattle. USDA ARS invented the “4-poster” to treat wild deer with permethrin. Although effective, the device was susceptible to disruption by raccoons, feral hogs, and other animals. A new, elevated design with just two application rollers was developed and is now in use throughout the quarantine zone of Texas. Scientists also improved cattle treatment for ticks by developing an ivermectin bait block that completely protects cattle after just four weeks, potentially eliminating the expensive process of dipping cattle each two weeks in infested pastures. In addition, trials of the GAVAC anti-tick vaccine showed that this older product killed 99.6% of one species of cattle fever tick, even though it did not affect the other species significantly. Combined with promising new vaccine

formulations developed from genomic studies of the tick, this work raises the possibility that anti-tick vaccination could become a useful tool for producers. This research not only protects the United States from reinvasion by cattle fever ticks, it also works toward making cattle production more economical in southern Texas.

Saving money for operational screwworm control: The screwworm fly is a dramatically damaging pest of the Western Hemisphere that lays eggs that hatch into flesh eating maggots on mammals, including humans and livestock. It used to be distributed as far north as the Midwestern US, but was completely eradicated from North and Central America by systematic distribution of sterile male flies by USDA. These flies must be reared, irradiated, and distributed -- a process that currently costs the US government approximately $10 million per year in order to establish a barrier of sterile flies between infested areas in South America and Panama. USDA ARS continues to improve the efficiency of the process by applying new technology. This year automated cryopreservation equipment was installed at the rearing plant, which eliminates the need to continuously rear a back-up colony and reference strains. Research identified chemicals that attract the flies to a site for egg-laying. Those chemicals will improve the rearing process by coordinating egg-laying by colony flies and also provide a better means of treating flies in small outbreaks. Scientists were able to genetically transform multiple lines of the flies, incorporating a marker protein and a cassette of DNA that induces the flies to produce only males. These accomplishments will reduce costs and increase reliability of rearing. A strain of flies that produces only males will save significant money in rearing costs, as well as reducing the level of radiation required to sterilize released flies.

2. Other ARS Research activities also designed to do no harm:

Invasive species information portal: The National Agricultural Library National Invasive Species Information Center (invasivespeciesifno.gov) web site provides an information gateway to invasive species information; covering Federal, State, local and international sources.

Information management support to ITAP: The National Agricultural Library provides information management support for the Federal

Interagency Committee for Invasive Terrestrial Animals and Pathogens (ITAP), a Federal scientific and technical interagency advisory group.

Overseas laboratories/quarantine facilities: Classical biological control is the use of natural enemies derived from a pest's point of origin. It offers the possibility for permanent, cost effective suppression of weeds and insect pests. The ARS Overseas Biological Control Laboratories (OBCL) are located in Australia, China, Argentina, and France and work as a cohesive network. Their collective mission is to identify, develop and ship natural enemies to stateside collaborators for use in U.S. programs designed to combat invasive species. Accordingly, they represent the beginning of a pipeline of effective biological control agents and numerous stateside programs rely upon them. The ARS OBCL has a rich history of success in this regard, having contributed numerous biological control agents now in use across the U.S. ARS OBCL maintains formal collaborations with APHIS, the U.S. Forest Service, the U.S. Fish and Wildlife Service, the Bureau of Land Management, the Bureau of Indian Affairs, and many State Departments of Agriculture.

Related to this overseas work, ARS maintains quarantine facilities for insects and pathogens that meet Federal safety specifications to preclude pest introduction into the U.S. When beneficial insects arrive from overseas, they are carefully sorted, screened for parasites and reared or cultured within the quarantine facilities. ARS operates laboratories with quarantine facilities in Albany, California, Florida, Maryland, Mississippi, and Montana. Each quarantine facility uses a variety of traps, doors, entryways and sanitizing procedures to keep the pests secure until they are proven safe for release into the U.S.

ARS is represented on the APHIS Technical Advisory Group for Biological Control Agents of Weeds (TAG). The purpose of TAG is to facilitate biological control of weeds in North America by providing guidance to researchers and recommendations to regulating agencies for or against the release of non-indigenous biological control agents. This is based on considerations of potential non-target impacts, conflicts of interest, natural resources, agricultural production, and the Endangered Species Act (ESA) Threatened and Endangered Species List.

ARS is also a member of the Federal Interagency for the Management of Noxious and Invasive Weeds (FICMNEW). FICMNEW has representatives from 16 federal agencies with direct invasive plant management and regulatory responsibilities spanning across the United States and territories. FICMNEW members interact on important national and regional invasive plant issues and share information with various public and private organizations participating with the federal sector to address invasive plant issues. It develops and shares scientific and technical information, fosters collaborative efforts among federal agencies, provides recommendations for national and regional level management of invasive plants, and sponsors technical/educational conferences and workshops concerning invasive plants. FICMNEW continues to bridge the gap between federal agency invasive plant management and science activities and has been a driving force behind the national emphasis against the broader invasive species threat.

ARS is a participant on the North American Plant Protection Organization Biological Control Committee that addresses the movement and regulation of biological control organisms used in either augmentation or classical biocontrol agents intended for release into the environment with expected establishment and pest control.

3. Activities that are doing harm, and future agency actions to change them so that they do not continue to do harm.

None. As the principal in-house research agency for the United States Department of Agriculture, ARS conducts research to develop and transfer solutions to agricultural problems of high national priority. ARS scientific studies provide data and develop tools that enable America to change potentially harmful actions into those that do no harm while still meeting the challenge posed by invasive species.

B. National Institute of Food and Agriculture (NIFA) (previously named the Cooperative State Research, Education and Extension Service- CSREES)

1. Activities to do no harm

Technical Advisory Group for the Biological Control of Weeds: NIFA is a member of the Technical Advisory Group (TAG) for the Biological Control of Weeds. This advisory group is made up of representatives from various Federal agencies that evaluate candidate biological control agents for their economic, environmental, and ecological safety. Should the candidate biocontrol agents receive approval for release against a given target weed, this helps ensure that harmful non-target effects from the natural enemies are minimized. TAG advises APHIS.

National Animal and Plant Diagnostic Laboratory Networks: The safety of U.S. plant and animal production systems depends on our ability to rapidly identify foreign pathogens and other pests, whether introduced intentionally (through bio-terrorism) or unintentionally. NIFA has established two national networks of existing diagnostic laboratories to rapidly and accurately detect and report pathogens of national interest and to provide timely information and training to state university diagnostic laboratories.

The National Plant Diagnostic Network is led by five regional laboratories (Cornell University, University of Florida, Michigan State University, Kansas State University, and University of California-Davis) and one support laboratory (at Texas Tech. University).

The National Animal Health Laboratory Network (NAHLN) is led by 12 Core Laboratories and 58 total laboratories (receiving training/reagent/exercise support and being linked) in 43 states. NIFA is currently helping labs (other than the 12 core laboratories) with funding to set up electronic (secure, standards-based) messaging regarding FAD findings. These facilities will help to link growers, field consultants and other university diagnostic labs to coordinate regional detection and provide inter-regional communication in the event of an outbreak. For more information on the NAHLN see

http://www.aphis.usda.gov/animal_health/nahln/downloads/NAHLNBriefingCurrent.pdf

2. Other Agency Activities, also designed to do no harm

Integrated Pest Management**:** Section 15 of the Federal Noxious Weed Act of 1974, and the Executive Order 13112 on Invasive Species (signed in 1999) direct Federal agencies to use an integrated pest management (IPM) approach for the management of undesirable plants on Federal lands using all available tools, including: education; preventive measures; cultural, mechanical, physical, biological and chemical control; and general land management practices such as revegetation, manipulation of livestock or wildlife grazing, and improvement of livestock and wildlife habitat.

Integrated Pest Management provides a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks. The adoption and utilization of IPM is being encouraged through other legislative authorities within Federal departments. For example, US Code (Title 7, Chapter 6, Subchapter II, Sec. 136r-1. Integrated Pest Management**)** states: "The Secretary of Agriculture, in cooperation with the Administrator, shall implement research, demonstration and education programs to support adoption of Integrated Pest Management." It further states "Federal agencies shall use Integrated Pest Management Techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies and other activities. IPM is also being encouraged across Federal agencies within the Department of the Interior.

Because of the complexity of economic, social, and environmental issues associated with invasive species management, and the biological and ecological attributes associated with each particular invasive species, programs that are based on a combination of technologies tend to be

most successful and sustainable. As indicated in the National Invasive Species Council's (NISC) National Invasive Species Management Plan of 2001, the IPM approach considers the best available scientific information, updated target population monitoring data, and the environmental effects of control methods in selecting a range of complementary technologies and methods to implement to achieve a desired objective. Some of the factors to consider in selecting control methodologies include environmental compatibility, efficacy, cost-effectiveness, inter-compatibility of different types of control measures, practicality and safety. The adoption of an IPM approach for invasive species management will certainly help minimize harm to the environment, human health and wildlife.

3. Activities that are doing harm and future agency actions to change them so that they do not continue to do harm

Pesticide use that has negative impacts: Conventional pest management strategies using pesticides are still emphasized in the management of invasive species with potential negative side effects to humans, the environment and wildlife. NIFA is helping to facilitate the adoption of an Integrated Pest Management Roadmap (IPM Roadmap) that will certainly help minimize harm to non-target species and the environment.

The goal of the IPM Road Map is to increase nationwide communication and efficiency through information exchanges among Federal and non-Federal IPM practitioners and service providers including land managers, growers, structural pest managers, and public and wildlife health officials. Development of the Road Map for the National Integrated Pest Management (IPM) Program began in February 2002, with continuous input from numerous IPM experts, practitioners, and stakeholders. The Road Map identifies strategic directions for IPM research, implementation, and measurement for pests in all major settings, throughout the nation. This includes pest

management for areas including agricultural, structural, ornamental, turf, museums, public and wildlife health pests, and encompasses terrestrial and aquatic invasive species.

The goal of the National IPM Program is to increase the economic benefits of adopting IPM practices and to reduce potential risks to human health and the environment caused by the pests themselves or by the use of inappropriate pest management practices.

Pest Management Grant Programs: NIFA has several competitive grant programs designed to emphasize IPM, while reducing pesticide residues on food and in the environment. These include the Pest Management Alternatives Program, Integrated Organic Program, Methyl Bromide Transitions Program, Regional IPM Competitive Grants Program, and the IPM Centers. The emphasis of IPM and bio-based pest management in these NIFA competitive grant programs will certainly help minimize harmful side effects to non-target species and the environment when these strategies are used in invasive species management.

IPM^3 Training Consortium for Federal Employees: NIFA, in collaboration with Land Grant Universities and other Federal Agencies, has facilitated the development of an IPM distance education platform to provide IPM training to Federal workers involved in pest management issues and activities. Increasing the quality and consistency of IPM training among Federal agencies and their adoption of an IPM approach for invasive species management will certainly help minimize harm to the environment, to human health, and to wildlife. For more information on IPM^3 please visit the following website: www.umn.edu/ipm3.

Pest Information Platform for Extension and Education (PIPE): PIPE is a reporting and tracking system, developed collaboratively with the USDA Risk Management Agency, to manage pest and disease information flow via the Web.

The PIPE system provides real-time useful information to U.S. crop producers, and a "one stop shopping" center for timely, unbiased, national, and local pest information. PIPE fosters good farming practices by encouraging growers to: avoid unnecessary or ill-timed chemical applications; use the proper control tactics with the proper timing to manage crop loss risk; and document practices for crop insurance purposes. The PIPE system for soybean rust saved growers hundreds of millions of dollars in 2007 by providing real-time information that enabled the growers to avoid unnecessary chemical applications. Additional active ipmPIPE components include: soybean aphid, legume diseases, curcurbit downy mildew, pecan, and southern corn rust.

C. Economic Research Service (ERS)

1. Activities to do no harm

ERS is the main source of economic information and research from the U.S. Department of Agriculture. ERS research informs and enhances public and private decision-making on economic and policy issues related to agriculture, food, natural resources, and rural development.

Program of Research on the Economics of Invasive Species Management (PREISM): ERS initiated a new program of work in fiscal year 2003, the Program of Research on the Economics of Invasive Species Management (PREISM), to examine the economic issues related to managing invasive species in increasingly global agricultural markets. Through PREISM, ERS primarily funded extramural research through a competitive awards program that focuses on national decision making concerning invasive species of agricultural significance or affecting, or affected by, USDA programs. In addition to ERS-led analyses of invasive species issues, ERS has disbursed $6.8 million through the competitive awards program to 45 recipients, including universities, other USDA agencies, and private non-profit institutions, for research on the economics of invasive species during FY 2003 to FY 2008.

About $1.1 million per year were allocated for extramural agreements in FY 2005 and FY 2006, while $950,000 was allocated in FY 2007 and $970,000 in FY 2008. No Funds were allocated in FY 2009 through FY 2011. ERS also organized annual workshops from 2003 to 2011 to provide a forum for dialogue on economic issues associated with agricultural invasive species.

Accomplishments of PREISM and outputs of PREISM-funded projects are reported in **Program of Research on the Economic of Invasive Species Management: Fiscal 2003-2011 Activities, which can be access at:** http://www.ers.usda.gov/publications/AP/AP056/.

Following are some preliminary findings from PREISM-funded research projects:

- Prevention and management resources should be allocated to species and strategies with the highest return (in terms of damage reduction over time). Ideally, marginal benefits and costs should be equal across species and strategies.

- Decision-support tools that follow sound economic principles and reveal underlying scientific assumptions and value judgments provide a basis for expert and stakeholder involvement in decision-making and promote efficient allocations of funds.

- Optimal invasive species management strategies depend upon the stage of the invasion and associated rates of growth and spread. Eradication may be optimal for small invasions; reduction to a containment level for larger invasions. If eradication is feasible, the effort will reduce discounted damages more if it occurs early when populations are small. Delays result in more damages. If total cost increases rapidly as population increases, eradication when the population is small followed by prevention may be the best strategy.

- Under-funded eradication or management efforts can be cost-ineffective or wasteful, with little or no effect on invasive species growth and total damage. Higher initial expenditures can reduce long term damages and control costs, even if the species is not eradicated.

- For established invasive species infestations, per unit costs of removal can increase as populations decrease or become more isolated, making complete eradication difficult or cost-inefficient. In some cases, accommodation to low levels of invasion is economically preferable to the high cost of eradication. The higher is the cost of removal, the larger the population that will be accommodated.

- Higher invasive species infestation or population growth rates reduce benefit-cost ratios of control efforts, and at high enough rates, control might not be worthwhile. If population has surpassed that of maximum growth rate, the best strategy could be a pulse-like effort that drives populations below a critical population level and growth rate, followed by containment strategy.

- Probability of occurrence maps for invasive weeds based on GIS and other inventory or survey data and related population growth rates can improve weed management efficiency by reducing: 1) costs by targeting sites to monitor invasiveness, and/or 2) damage by initiating control of highly invasive populations before they spread.

- Coordination of regulations across U.S.-Canada, State, and provincial boundaries could: 1) more effectively reduce the cross-border spread of exotic horticultural plants that become invasive, and 2) reduce incentives for cross-border firm relocations to take advantage of more lenient regulations.

- Ecological and agronomic differences influence cross-State differences in noxious weed and weed-seed lists, but stakeholder lobbying also has significant effects.

2. Other Agency Activities, also designed to do no harm

ERS is not engaged in any activities that do harm.

3. Activities that are doing harm and future agency actions to change them so that they do not continue to do harm

None.

II. USDA Regulatory and Resource Management Agencies

A. Animal and Plant Health Inspection Service (APHIS)

1. Activities to do no harm

"Protecting American agriculture" is the basic charge of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS). APHIS provides leadership in ensuring the health and care of animals and plants. The agency improves agricultural productivity and competitiveness and contributes to the national economy and the public health. APHIS has major regulatory authority to implement action programs to achieve these responsibilities. For more detailed information and up to date highlights of program activity, please visit the APHIS Web Site (http://www/aphis.usda.gov/).

Invasive Species Prevention Programs: Specifically the APHIS mission, stated in its current strategic plan, is to protect the health and value of American agriculture and natural resources. To carry out this mission, APHIS works to achieve two interdependent goals:

- Safeguard the health of animals, plants, and ecosystems in the United States (U.S.)
- Facilitate safe agricultural trade

It does so through a system of interdependent objectives addressing exclusion (i.e., prevention), detection, emergency response, management, trade issue resolution, and capacity

building. These areas correspond closely to elements of the 2001 National Invasive Species Management Plan.

APHIS tries to ensure that other entities in the private and public sectors, including other Federal agencies, "do no harm" by introducing or spreading invasive species. APHIS prevention programs – a comprehensive set of risk-based regulations and enforcement efforts -- are directed at animals, plants, and their products that may bring invasive species or be pathways for the introduction of invasive species. As such, the Agency addresses both unintentional and intentional introductions of invasives. A description of some of the applicable regulations follows.

1. Regulation of certain animals and animal products:
APHIS regulates, as set forth in 9 CFR parts 91 through 99, the importation of animals and animal products to guard against the introduction of animal diseases into the U.S. in accordance with the Animal Health Protection Act.

2. Regulation of certain plants and plant products:
Regulations contained in 7 CFR part 319 prohibit or restrict the importation of plants, plant parts, and plant products into the U.S. in accordance with the Plant Protection Act. APHIS enforces the part 319 regulations and considers requests to amend the part 319 regulations to allow the importation of plants, plant parts, or plant products that are not currently allowed importation under the regulations. The requirements apply to many commodities, including nursery stock.

3. Listing of noxious weeds:
Under the authority of the Plant Protection Act, APHIS regulates, in 7 CFR parts 360 and 361, the importation and interstate movement of plants and plant products that may be noxious weeds, i.e., plants that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture,

irrigation, navigation, the natural resources, public health, or the environment.

Plant Epidemiology and Risk Analysis Laboratory (PERAL): PERAL is a diverse group of scientists and professionals comprising the primary office in Plant Protection and Quarantine (PPQ) for pest risk analysis. PERAL is responsible for providing essential scientific support to risk-based policy making across a broad range of phytosanitary issues. The staff uses scientific principles, procedures and evidence to analyze issues relevant to safeguarding plant health from the threats of harmful exotic pests of cultivated and natural plant systems. This includes most risk analyses required by PPQ for pests, Commodities, and pathways but it does not currently include risk analyses associated with plant pest permits, genetically modified organisms, or Federal Noxious Weeds.

PERAL serves a wide range of functions within PPQ. The overarching responsibility is to provide comprehensive, accurate information in support of the decision making process ensuring that resulting actions are the most appropriate and "Do No Harm". For more in-depth information regarding PERAL, please visit http://cphst.aphis.usda.gov/plant health/cphst/peral.shtml

A good example of one of these functions is the New Pest Advisory Committee: The New Pest Advisory Group (NPAG) is located in the APHIS Center for Plant Health Science and Technology (CPHST), Plant Epidemiology and Risk Analysis Laboratory (PERAL). The overall goal of NPAG is to safeguard American agriculture and natural resources. The NPAG assesses new and imminent exotic plant pest introductions into the U.S. to recommend appropriate Plant Protection and Quarantine's (PPQ) policy and actions to respond to the potential threat posed by such pests. In this case a pest is defined as: *Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products* [FAO, 1990; revised FAO. 1995; IPPC, 1997].

NPAG may address pests in many taxa including arthropods, plant pathogens, mollusks and weeds. It determines whether the pest is a present or an imminent threat, and if the pest meets the definition of a quarantine pest. If the pest meets the definition, NPAG may convene an ad hoc panel of Subject Matter Experts from PPQ, other Federal, state, and university sources with regulatory and scientific expertise for that particular exotic pest. Through literature searches, data sheet preparation and discussion with the panel, NPAG provides findings and recommendations via the NPAG Report to the APHIS Deputy Administrator and the APHIS Executive Team (represented by PPQ's management) in response to the pest introduction.

APHIS Wildlife Services (WS) Activities

Nonnative, invasive species can be devastating to ecosystems where a lack of natural enemies and competition for resources can allow these species to thrive, wiping out other native wildlife in the process. APHIS WS' efforts target these introduced and invasive species. Invasive species of concern include brown tree snakes (BTS), Gambian rats, nutria, Coqui frogs, pigeons and starlings, house sparrows, feral swine and Burmese pythons.

1. Feral swine are an introduced species that pose a number of threats to humans, livestock and wildlife. Among these threats is the ability of feral swine to harbor a variety of federally regulated pathogens whose presence would result in severe economic loss to livestock industries. Estimates of economic losses from feral swine to agriculture and the environment average $800 million annually. Feral swine have established populations in 38 states and are spreading rapidly. WS removed 29,427 swine in 31 states in FY 2010.

2. European starlings are an invasive species that invade livestock facilities, eating and defecating in feed bins. This fouling causes severe economic losses to the farmer and transmission of disease and loss of production in the animals. Estimates of economic losses due to starlings

range from $800,000 - $4,137,119 annually in the U.S. WS removed 2,511,258 starlings from livestock facilities in 44 states in FY 2010

3. Brown tree snakes have eliminated 10 of the 13 native bird, most lizard, and bat species on the island of Guam, are responsible for large economic losses from damaged electrical lines and resultant power outages, and pose a hazard to human safety from bites. APHIS continued to prevent the unintentional introduction of the BTS from Guam to other Pacific Islands, Hawaii, and the continental United States in FY 2008. The Agency intercepted 24,920 BTS on Guam or near ports of exit. APHIS WS National Wildlife Research Center scientists at the Fort Collins, Colorado headquarters, conducted an economic assessment of a hypothetical translocation of the BTS from the Territory of Guam to the Hawaiian Islands. The total annual projected economic impact of the translocation of BTS to Hawaii was estimated to fall within the range of $473 million to $1.8 billion. These projections underscore the value of a BTS interdiction and control program on Guam.

4. The Gambian rat is a very large rodent native to northern Africa. Gambian rats can harm livestock species and habitats, damage agricultural crops, consume livestock feed, and are associated with a variety of pathogenic diseases that could be spread to humans, livestock, and wildlife. APHIS continues to work with the Florida Fish and Wildlife Conservation Commission, U.S. Fish and Wildlife Service, South Florida Water Management District, and the Florida Park Service to move toward the eradication of the Gambian rat from the Florida Keys. Removal methods have been successful and rat numbers are down significantly over previous years.

5. Nutria are large, semi-aquatic rodents native to South America, but are now established in 17 states and cause extensive damage to wetlands, agricultural crops, and structural foundations such as dykes and roads. The

rodents may also threaten human health and safety and serve as a reservoir for tularemia and other diseases. APHIS is leading the first large-scale North American effort to eradicate a mainland population on the Delmarva Peninsula in Maryland where the rodents have devastated coastal Chesapeake Bay marshes. In cooperation with the Department of Interior's Fish and Wildlife Service, Maryland Department of Natural Resources, U.S. Geological Survey (USGS), Tudor Farms (a 6000-acre private wildlife management area) and 300 private landowners, APHIS has completed the initial nutria removal from more than 150,000 acres of coastal marsh in Maryland. The Agency is now expanding the search for established populations in major tributaries leading into the region. The Agency's wildlife specialists have developed and refined new removal techniques and have partnered with USGS to develop new detection and monitoring techniques including remote triggered cameras, call-back surveys, and other means of detecting low density populations. Through careful population monitoring, APHIS has successfully prevented the re-infestation of this area, and marsh grasses and native muskrat populations are quickly recovering throughout the previously-impacted area.

In addition to the species highlighted, APHIS provides assistance to the general public upon request to resolve damage caused by invasive species. Last Fiscal Year, APHIS provided direct control assistance to resolve damage caused by 14 of the 23 bird, mammal, and reptile species identified by the World Conservation Union (IUCN) as being among the top 100 invasive species in the world. These species included: BTS, giant toad, Coqui frog, red-vented bulbul, common myna, European starling, nutria, house mouse, roof rat, small Asian mongoose, feral swine, cats and goats.

APHIS Veterinary Services (VS) Activities

1. National Animal Health Laboratory Network (NAHLN) is a state-federal cooperative effort including the APHIS National Veterinary Services Laboratories, which provide

reference and confirmatory laboratory services including training, proficiency testing, and prototypes for diagnostic tests. The State/University laboratories in the NAHLN perform routine diagnostic tests for endemic animal disease as well as targeted surveillance and response testing for foreign animal diseases. The network will assist in early detection and rapid, scalable response to an exotic animal disease. For example, over 40 laboratories have been trained and proficiency tested to perform foot and mouth disease (FMD), avian influenza (AI), and exotic Newcastle surveillance diagnostics. A surveillance program for classical swine fever (a vesicular disease present in the Dominican Republic and Haiti) was established using NAHLN laboratories.

2. Cattle fever is a severe and often fatal disease of cattle transmitted by two species of tick. The ticks were eradicated from the continental US in 1943, with the exception of a buffer zone between Texas and Mexico. An increase in movement of deer and stray livestock across the border has led to increased fever tick infestations in recent years despite a partial tick control border fence, livestock movement quarantines, and tick treatments for cattle and deer. APHIS is collaborating with ARS and the Texas Animal Health Association to explore alternative methods of tick control including baiting stations with acaracide-impregnated rollers and anti-tick vaccines.

3. APHIS continues to cooperate with CDC, State animal and public health officials in response to swine influenza spillovers into humans (and vice-versa). Epidemiology, virus sequencing and characterizations are performed to assess the risk of establishment and spread within the species.

4. Foot and Mouth Disease is the most communicable disease known, and is exotic to the US. APHIS activities have recently included vaccine and pen-side diagnostics studies, characterizing the pathogenesis and clinical signs

in feral swine, and examining susceptibility of U.S. wildlife ruminant species. Validation of bulk-tank milk testing, virus-inactivating sample collection paper (allowing increased laboratory capacity) studies are ongoing.

5. The policy regarding FMD vaccination vs. stamping out has shifted to make vaccination more likely in a large outbreak, in turn making eradication more likely in multiple scenarios. "Safe-Egg" and "Secure Milk Supply" plans for AI and FMD are being developed with commodity groups and universities, making compliance more likely, in turn making eradication more likely.

6. Rift Valley Fever is an arthropod-borne zoonotic disease (infects humans and non-humans) of Africa. U.S. mosquito species have been proven competent. APHIS activities have recently included diagnostic test validation, geospatial collaborations, and vaccine approval advice and steps.

7. Nipah virus is spread from fruit-eating bats to swine that can infect humans (from bats or swine). APHIS has collaborated with DHS and others with vaccine approval advice.

8. APHIS has changed regulatory requirements for surveillance and pre-movement testing of livestock for brucellosis and tuberculosis after consultation with states, tribes, and the animal industry. These diseases of wildlife, livestock and humans currently exist only in limited wildlife foci in the US. The changes should allow more efficient use of resources to allow continued control of the disease.

9. APHIS is partnering with university and industry entities to increase the value of its disease spread modeling programs by adding livestock movement data. An exotic or emerging animal disease would likely move most quickly through current production-oriented animal movement.

10. A ‘dashboard’ allowing visualization of sampling, outbreaks, response measures, laboratory capacities, etc., has been developed in collaboration with DHS and one of their Centers of Excellence, which should allow syndromic surveillance (earlier detection) and more rapid and effective response to foreign and emerging diseases.

2. Other Agency Activities, also designed to do no harm

Program protocols: APHIS also follows protocols to ensure that its own activities and those of its State cooperators, carried out to exclude, detect, diagnose, control, and eradicate invasive species, do not contribute to the problem. These ongoing efforts include, in a general sense, agency personnel adherence to established biosafety procedures in programs to detect, diagnose, and conduct control operations for plant and animal diseases and pests, both in laboratories and in the field; and assessment, in advance, of the probable impact of the use of biocontrol agents in programs to control invasive species.

3. Activities that are doing harm, and future agency actions to change them so that they do not continue to do harm

None. APHIS actions are consistent with the “DO NO HARM” objective of the Presidential Executive Order on Invasive Species.

B. Natural Resources Conservation Service (NRCS)

1. Activities to do no harm

The NRCS is well aware of the past, the present, and the potential future harm to the private lands in the U.S. from invasive species. The negative environmental and economic impacts of invasive species continue to be a large and growing problem for our Nation’s private landowners.

The primary invasive species focus for NRCS has been on terrestrial and aquatic invasive plants. Invasive plants have had large negative environmental impacts upon the intended uses of many privately owned lands and wetlands in the U.S. There have also been large negative economic impacts associated with the costs of invasive plant control. Invasive plants compete for soil nutrients and water in croplands and wild lands and often require the use of herbicides, biological control agents, or innovative control techniques. Invasive plants, often of poor forage quality, may out-compete native plants in grazing lands and wild lands rendering large acreages no longer useful for supporting livestock or wildlife. Invasive aquatic plants rapidly spread in water bodies and wetlands, removing the open water component necessary for many wildlife species. Of particular concern are the negative impacts from invasive plants, invasive invertebrates, and pathogens upon populations of native and introduced pollinators and their habitats as well as upon native threatened or endangered species and their habitats. The invasive species could have devastating effects on desirable cropland and wild land plants and animals.

Publication and Revision of Agency Invasive Species Policy:
NRCS published its NRCS Invasive Species Policy in November 2004 and revised it in July 2010. The policy is available at **http://policy.nrcs.usda.gov/scripts/lpsiis.dll/GM/GM_190_414.htm**. The policy addresses the invasive species responsibilities at all levels (e.g., National Headquarters, Regional, State, and Field offices) of the agency. It requires awareness by NRCS employees of the presence of invasive species and potential problems associated with them. It requires NRCS to work with partners and to use its human and financial resources for control, suppression, and/or eradication of invasive plants. The policy also requires that native plant species be used in vegetative conservation practices unless it can be demonstrated that no native species can achieve the desired conservation goals, or the desired native species is not available in the quantity required. Interim use of non-native

species is allowed to provide the conservation function desired until native species can be established.

Assisting in the control and eradication of invasive plants: NRCS provides U.S. private landowners with financial and technical assistance to control and/or eradicate invasive plants in an effort to maintain the desired vegetation (e.g., food crops and forage), to maintain the desired characteristics of the land (e.g., wetland open water), and to diminish invasive plants spreading to neighboring lands. NRCS frequently partners with local and regional weed control organizations for control of weeds on and off private lands. The agency encourages the use of integrated pest management (IPM) which may involve appropriate herbicides when necessary, the use of approved biological control organisms, and innovative cultural control methods for specific problems (e.g., black plastic). NRCS has placed increased emphasis upon the protection of wildland habitats for pollinators and other wildlife

Landowners that participate in some of the easement programs of NRCS (e.g., Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP)) are required to control invasive plants that might infest the easement lands. CRP and WRP participants may receive some financial assistance to maintain these lands free of invasive plants. The Wildlife Habitat Incentives Program, Environmental Quality Incentives Program and the Conservation Stewardship Program also provide technical and financial assistance to help private landowners control invasive plants.

NRCS Conservation Practice Standards: NRCS has created a toolbox of 170 practice standards that provide guidance for applying conservation technology on the land and that set the minimum levels for acceptable application of the technology. These practice standards undergo periodic review for incorporation of new technology (generally every 5 years). Emphasis continues to be placed upon the identification and consideration of the invasive qualities of recommended vegetation, the use of native vegetation, and the protection and enhancement of pollinator habitat.

The NRCS Plant Materials Centers (PMCs): The 27 PMCs nationwide cultivate and provide seed stock of plants that are used for vegetative conservation practices within the geographical region served by each PMC. The PMCs encourage use of native plants, particularly source-identified plants, for restoration, reclamation, and conservation practice uses. The Plant Materials program uses an Environmental Evaluation to assess the potential invasiveness of plants being considered for release. If the potential for invasiveness is too great, other plants considered less invasive for the particular environmental conditions are recommended.

The PMCs also used the Environmental Evaluation to review all prior NRCS conservation plant releases. For plant releases that were determined to be invasive or otherwise environmentally harmful, the PMCs discontinued their production. Once a PMC discontinues a plant release, the NRCS plant materials specialists work with the appropriate states to remove the invasive plant releases from NRCS State standards and recommendations so that plant is not recommended in the future.

2. Other Agency Activities, also designed to do no harm

PLANTS Database: The information about plant materials available through the PLANTS database (http://plants.usda.gov) is useful to conservation professionals and the public in determining beneficial plants that do well within a particular geographical location. It also has information on plants which should not be planted within a particular environment (e.g., Federal and State noxious weed lists). The database information provides help to assess the potential invasiveness of specific plants. The PLANTS database has over 650 fact sheets on-line line and provides services through over 70,000 user sessions per day. It encourages the use of native plants in conservation practices. Future capabilities will include information about the pollinators upon which specific plants are dependent, and recommended forage to encourage specific pollinators.

3. Activities that are doing/have done harm, and agency actions to change them so that they do not continue to do harm

Recommending invasive plants in conservation plans. During the "Dust Bowl" days of our nation, immediate action was necessary to mitigate excessive wind and water erosion of our nation's soils. Unfortunately, one of the mitigation tools that worked effectively was the use of non-native plant materials, some of which became invasive and presently are among the invasive plant materials we are trying to control. The use of the Environmental Evaluation by the PMCs before recommending specific plant materials for conservation is proving to be beneficial to avoid present and future problems of this kind. Also, encouraging the use of locally-acquired native plants whenever they can meet the conservation needs is enhancing awareness to NRCS state and field offices about invasive species problems and NRCS responsibilities.

The implementation of the NRCS Invasive Species Policy has made clear to all levels of the agency the responsibilities to respond to invasive species problems, and to minimize or avoid future invasive species problems.

The state-specific Field Office Technical Guides are technical guidance information for the specifics of each conservation practice standard within the specific State. Technical Guides may, in some cases, still recommend the use of plant materials that may become invasive. NRCS has conducted and continues a review of all vegetative conservation practice standards to identify where this situation exists, and to work with the appropriate PMCs and State Plant Materials Specialists to recommend other appropriate and non-invasive plant material.

Use of herbicides or other methods that may have detrimental effects on native pollinators: The treatments recommended in some conservation practice standards for invasive plants may, in some cases, include the use of herbicides or other methods

that may have detrimental effects directly or indirectly (e.g., habitat destruction) on native pollinators. NRCS continues to review and to revise all practice standards to identify such methods, and to recommend revisions that minimize or eliminate negative impacts to native pollinators. NRCS is developing a module within the PLANTS database that identifies specific plant-pollinator relationships and encourages the use of "pollinator friendly" plants in agricultural and wild land situations.

C. U.S. Forest Service (FS)

1. Activities to do no harm

Invasive activities on 193 million acres of National Forests and Grasslands: The Forest Service increased activities across the 193 million acre National Forest System to prevent, control, and eradicate aquatic and terrestrial invasive species (including invasive plants, pathogens, vertebrates, and invertebrates, etc.). In FY 2011 the National Forest System (NFS) treated over 352,090 acres of lands and waters infested with invasive species, of which approximately 70,339 acres targeted non-plant invasives, down nearly 36% from FY2010. In 2011, the national average outcome performance level for the percentage of priority acres restored/protected on NFS was 75.2% treatment efficacy, a 3.6% decrease from FY2010.

Supported establishment of Cooperative Weed Management Areas (CWMA) and Cooperative Invasive Species Management Areas (CISMA): In FY 2011, the National Forest System programs increased support for a national initiative with federal, state, and local partners to expand the establishment of CWMA's and CISMA's across all states. Using models from areas of the country where they have been effective, the USFS continued to support a CWMA and CISMA development and mentoring program. The National Forest System provided $350,000 in support for the Pulling Together Initiative in partnership with the National Fish and Wildlife Foundation to support CWMA and CISMA establishment.

Policy Development - For invasive species management in National Forests and Grasslands: The proposed new Forest Service Manual (FSM 2900) for invasive species management on the National Forest System was released for public comment in the Federal Register in June 2011 for a 60-day comment period. Responses were received from a wide variety of public and private organizations, largely supporting the new policy and encouraging the agency to move forward with a coordinated, all taxa approach in the final version. Edits and approvals for the Federal Register notice for the final version were completed by late summer, with expectation that OMB will give final clearances for implementation by winter 2011.

Policy Development - NFS Invasive Species Management Handbook: The new Forest Service Manual 2900, will tier into an accompanying Forest Service Handbook (FSH 2909.11 – NFS Invasive Species Management Handbook) is being developed. A national team has been established to build the draft content; which will articulate specific guidance, standards, criteria, rules, procedures, including, but not limited to: 1) Roles and Responsibilities for Invasive Species Management on the National Forest System, 2) Integrated Management Guidance, 3) Invasive Species Prevention and Control Procedures, 4) Invasive Species Early Detection and Rapid Response Criteria and Procedures, 5) Internal and External Coordination, 6) Record Keeping and Reporting, 7) Invasive Species Management Planning and Environmental Complicance/NEPA, 8) Contract and Permit Requirements and Related Oversight, 9) Inventory, Survey, Monitoring and Treatment Protocols, and 10) Invasive Species Management Program Training Requirements and Standards. The development of the new policy (Handbook) is expected to continue through CY2011 and into CY2012.

Training, funding and technology for invasives work: NFS conducted and/or provided technical and financial support for numerous invasive species training workshops, educational programs, community outreach activities, and developing technology for invasive species management solutions.

Invasives Species Management Record Keeping and Reporting. The National Forest System invasive species data management applications were redesigned and improved to include key aspects of invasive species treatment and inventory work, as well as new program performance measures. Guidance and FY2011 Program direction to Forest Service regions, national forests, and forest districts was provided through several channels and available on-line. Improvements include the use of personal data recorders for quicker collection of field data (spatial and tabular) on all taxa of invasive species. Forest Service data applications continue to evolve as technology and security requirements change.

Updated USFS National Invasive Species Program Web Site: USFS has updated the portals, navigation, and content for the national website on invasive species. It provides user information on FS activities related to invasive species, policy, authorities, news and emerging issues. The site provides key contact information for invasive species program managers, access to cooperative projects and research, geographic information, species profiles, and techniques for preventing and controlling a wide variety of species. The website is http://www.fs.fed.us/invasivespecies/

FS activities in support of NISAW: The National Forest System provided continuing national support for the annual National Invasive Species Awareness Week (NISAW) activities in Washington, DC. Many Forest Service local and regional offices also conducted invasive species education and awareness activities with partners at the local level at the same time as the NISAW activities took place in DC, and throughout the year.

Completion of OIG Audit on the Invasive Species Program: On September 30, 2010, Assistant Inspector General for Audit, Gil H. Harden formally notified the Chief of the Forest Service that the USDA Office of Inspector General (OIG) had reached management decision on all recommendations in the subject audit report (Audit Number 08601-7-AT). The “Achievement of Management Decision” document articulated eleven (11) final

recommendations for improvements in the Forest Service invasive species program, inclusive of each of the key Deputy Areas (SPF, NFS, and R&D) involved in the program. For each OIG recommendation, the Forest Service provided it's response and corresponding timetable for completion of the final action(s). OIG recommendations included a number of major program changes needed to increase accountability and transparency in the program; including developing and implementing controls for reporting accurately how much the agency is spending to combat invasive species both locally and nationally, and implementing comprehensive national policy on invasive species management through the Forest Service Manual. The Forest Service is implementing actions agreed upon in the Achievement of Management Decision document to address the issues and recommendations identified by OIG. Several of the eleven (11) recommendations have been satisfied and given clearance from OIG.

Research on invasive species: FS researchers participated in a study funded by The Nature Conservancy, through the University of California at Santa Barbara's National Center for Environmental Analysis and Synthesis. The team recently published a paper that provides the most comprehensive estimates of the costs of non-native forest insects currently available for the U.S., the probability of future costs, and by extension, the benefits of reducing the rate of invasion. This work can be used in quantitative cost-benefit analysis of various exclusion measures for minimizing invasive species introductions.

- The analysis indicates that the cost of non-native forest insects is largely borne by homeowners and municipal governments, large constituencies that may not be adequately considered in most analyses. For all guilds, local government expenditures and residential property value losses were the two highest cost categories. Household expenditures were also high, which was partially reflected in property value loss.
- Timber value losses are relatively modest, often an order of magnitude lower than local government expenditures. Timber mortality induced by poster pests constituted a small fraction of

total timber volumes harvested from all tree species, so the impact on timber supplies are likely to be minimal. However, future biological invasions could have more severe impacts on timber species.

- More than 450 non-native forest insects are established in the United States. While the majority of these species have not caused detectable damage, 62 species have been reported to cause noticeable impacts (above background levels) to live forest trees. The “poster pests” identified for this study are each the most damaging species of its guild to date. They include the emerald ash borer in the borer guild, the hemlock woolly adelgid in the sap feeder guild, and the gypsy moth in the foliage feeder guild.
- Pests from the borer guild, which often arrive on wood packaging materials, generally exacted the highest total costs across sectors. At an estimated $1.7 billion in local government expenditures and approximately $830 million in lost residential property values each year, borers’ economic impacts were several times greater than impacts from other guilds. Of the three guilds, borers were represented by the fewest species, but a high proportion of them (20%) are damaging.
- The extent of damage caused by borers is particularly troubling because of the dramatic increase in rates of borer introductions over the last 30 years. Borers accounted for 56% of forest insect invaders detected from 1980-2006, compared to just under 11% before 1930. This most likely results from the increased importation of wood packing material that harbors borers. Our analysis indicated that there is a 32% risk that a new borer that is as damaging as, or more costly than, the emerald ash borer will invade in the next 10 years.
- Sap feeders accounted for the largest proportion of the insects in our database, but relatively few cause tree mortality or substantial damage. Of the three guilds, sap feeders caused

the least timber value loss; and the timber value loss caused by sap feeders was less than 5% of that caused by borers. Efforts to control or manage sap feeders received the fewest federal dollars ($14 million annually), although they caused substantial losses in real estate values - approximately $260 million per year.

- Costs associated with foliage feeders were substantially lower than costs associated with borers for all categories except annual federal expenditures, which were slightly greater ($110 million for foliage feeders and $92 million for borers). Foliage feeders were estimated to cause approximately $410 million per year in lost property value. Foliage feeders, such as gypsy moth, typically cause mortality only if consecutive years of severe defoliation occur, or under exacerbating circumstances such as drought, which is reflected in the lower costs of this guild.

Non-native forest insects and the damages they inflict are not unique to the United States. Insects native to the United States have spread to Europe and Asia and are causing damage to forests, and decision-makers in those countries are confronting issues similar to what we face in the United States. Our new analytical framework can be used in any country where data are available and can be easily adapted for estimating costs in a variety of natural resource disturbances in addition to invasive species, including fire, disease, and water quality, at scales from municipalities to nations.

Reference: Aukema, et al. 2011. Economic Impacts of Non-Native Forest Insects in the Continental United States http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0024587

USFS R&D is working to improve our use of internet sites to disseminate research results. Examples include:

NRS invasive species website contains information on key pests, (ie EAB, HWA, ALB, etc.) --- http://nrs.fs.fed.us/disturbance/invasive_species/

Southern Research Station Forest Threat accomplishments website --- http://www.srs.fs.usda.gov/science/threats_accomp.html

Rocky Mountain Research Station website -- http://www.fs.fed.us/rm/wildlife/invasives/

Pacific Southwest Research Station websites -- (http://www.fs.fed.us/psw/topics/insect_disease/ *http://www.fs.fed.us/psw/topics/invasives/strawberryguava/ &* http://www.fs.fed.us/psw/topics/invasives/strawberryguava/)

Pacific Northwest Research Station website -- (http://www.fs.fed.us/pnw/invasives/index.shtml)

2. Other Agency Activities, also designed to do no harm

Reprinting of USFS DVD's on Invasive Species Prevention: The second and third videos in the USFS DVD series on invasive species prevention best management practices were reprinted and released to the public. Both "Defending Favorite Places – How Hunters and Anglers Can Stop the Spread of Invasive Species" and "Playing Smart Against Invasive Species – How to Enjoy and Protect the Great Outdoors" have been high demand as valuable educational tools for all sectors. All the videos in the series are available on the web at http://www.fs.fed.us/invasivespecies/.

Evaluation of vehicle washing activities: The National Forest System continues to support the evaluation of vehicle washing activities/systems/protocols with public and private partners to evaluate the effectiveness of existing systems and mechanisms. Evaluations are based on a scientific approach to quantify effectiveness and determine treatment quality for various scenarios. Long term objectives of the project include building better protocols and contract specifications, and

ultimately better effectiveness at preventing the spread of invasive species by equipment and vehicles.

NFS Performance measures for invasives: The National Forest System maintained strong performance and accountability system measures for all invasive species program activities, nationwide. Field data was collected in corporate data management applications, and validated per the business rules and requirements. Program performance is outcome-driven and will emphasize the effectiveness of treatments. All NFS invasive species program performance outputs and outcomes were incorporated into the Forest Service Performance Accountability System for upward reporting in FY 2011.

Prevention language in FS contracts: In FY 2011, the National Forest System reviewed and evaluated specific invasive species 'prevention' language which may be included in project contracts, agreements, and permits (such as timber sales, road management, facility construction, easements, grazing allotments, maintenance of right-of ways, facility operations, etc.) that specify requirements to minimize or prevent invasive species infestations and spread on national forests and grasslands.

3. Activities that are doing harm, and future agency actions to change them so that they do not continue to do harm

None.